

2771-260-CIPDIV-RCE

Section II (Remarks)**Pending Claims**

Claims 1-4, 6-7, 10, 12-22, 24-26, 31-36, and 38-45 are pending. Claims 5, 8-9, 11, 23, 27-30 and 37 have been previously cancelled.

Allowed Claims

Claims 6, 10, 12, 24-25, 31-34 and 40-41 have been allowed. Applicants thank the Examiner for indicating allowance of these claims.

Amendments to the Claims

Claims 1-4, 6-7, 10, 12-22, 24-26, 35-36, 38-39 and 42-45 have been amended, as noted herein. Specifically, claim 1 has been amended to recite the claim in a form for added clarity without departing from the scope of the claim. Likewise, claims 2-4 also have been amended to recite the claims in form for added clarity and to amend the leading "A" to "The" because claims 2-4 are dependent claims depending from base claim 1. Claim 6 has been amended to replace the leading "A" to "The" because claim 6 is a dependent claim depending from base claim 31.

Similar amendments have been made to claims 7, 10, 12-22, 24-26, 35-36, and 38-39. In view of amendments to base claims 1, 16, 35 and 36, claims 38-39 and 42-45 have been amended to replace the term "organic solvent solution" with the term "organic solvent" as there is no longer antecedent support for the term "organic solvent solution" in the base claims from which claims 38-39 and 42-45 depend. The foregoing claims have also been amended, where appropriate, to insert the proper verb (e.g., "are" instead of "is") for grammatical correctness.

The above noted amendments are directed to form and to present the claims in clearer and more succinct fashion. The above-noted claim amendments are supported by the specification originally filed including the original claims. Accordingly, no new matter (35 U.S.C. § 132) has been introduced.

Claims Rejection(s) under 35 U.S.C. § 102(e) over Vaartstra

Claims 1, 3, 4, 16, 17-22, 26, 35 and 36 are rejected under 35 U.S.C. § 102(e) as being anticipated by Vaartstra (U.S. Patent No. 5,695,815) for the reasons noted at pages 2-3 of the Office Action. Applicants respectfully traverse this rejection for the reasons noted below.

Before fully addressing the merits of this rejection, it is important to have an understanding of various claim terms appearing in base claims 1, 16, 35 and 36. In particular, claims 1 and 35 each recite the following relevant language:

wherein said steps (a) and (b) are carried out by a process selected from the group consisting of chemical vapor deposition (CVD), assisted-CVD, ion plating,

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rapid thermal processing, and molecular beam epitaxy. [(Emphasis added.)]

Note that “said steps (a) and (b)” refer to “decomposing” step (a) and to “depositing” step (b).

Likewise, claims 16 and 36 each recite similar relevant language:

wherein the decomposition of the precursor and deposition of iridium on the substrate are carried out by a process selected from the group consisting of chemical vapor deposition (CVD), assisted-CVD, ion plating, rapid thermal processing, and molecular beam epitaxy. [(Emphasis added.)]

The above-noted claim language from claims 1, 16, 35 and 36 is incorporated into their dependent claims (*i.e.*, claims 3-4 depending from claim 1; claims 17-22 and 26 depending from claim 16). Bearing the foregoing claim dependency and remarks in mind, Applicants now address the understanding of one of ordinary skill of the terms “chemical vapor deposition (CVD)”, “assisted-CVD”, “ion plating”, “rapid thermal processing” and “molecular beam epitaxy” to the extent necessary to rebut the rejection of record.

Each of the foregoing terms (*i.e.*, “chemical vapor deposition (CVD)”, “assisted-CVD”, “ion plating”, “rapid thermal processing” and “molecular beam epitaxy”) refer to a vapor or volatile deposition technique as noted by their relevant description indicated and reproduced below.

Chemical vapor deposition (CVD) – as that term itself implies – involves the “vapor” deposition of a given species:

Chemical vapor deposition (CVD) is a chemical process often used in the semiconductor industry for the deposition of thin films of various materials. In a typical CVD process the substrate is exposed to one or more volatile precursors, which react and/or decompose on the substrate surface to produce the desired deposit. Frequently, volatile byproducts are also produced, which are removed by gas flow through the reaction chamber. [(See relevant web pages from Answers.com – copy attached; emphasis added.)]

Likewise, “assisted-CVD” is another form of a CVD process technique so that it (the former) too involves vapors, volatile precursors and/or volatile by-products. Thus, our above noted remarks regarding CVD apply equally to the term “assisted-CVD.” The import of the foregoing quoted language is that “CVD” and “assisted-CVD” are vapor processes that involves deposition of volatilized species (via conversion into vapor form).

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The term "ion plating" is described as follows:

Ion plating is a physical vapor deposition technique to form metal coatings on metals and alloys.

The specimen to be coated is placed in an inert gas (often argon), together with some coating material. Next, a certain **heating temperature and low-voltage arc is applied to evaporate the metallic component of the coating material.** The ionized particles are accelerated to a high energy, and the coating is formed due to the bombardment of these accelerated particles, reaching the specimen to be coated. [(See relevant web pages from Answers.com – copy attached; emphasis added.)]

In view of the foregoing quoted language, as with CVD, "ion plating" involves evaporating the precursor into a vapor form. Another consistent definition of "ion plating" is as follows:

Ion plating

[DEFINITION]

A vapor deposition in which the vaporized particles are ionized or energized in plasma and deposited on the substrate by applying kinetic energy through an electric field. [(See relevant web page – copy attached; emphasis added.)]

Likewise, "rapid thermal processing" is described as noted below involving gas and heat:

Rapid thermal processing
Rapid thermal processing (or RTP) is **conducted on the product (e.g., solar cells) in a high temperature oven.** The **gas and heat combine to accelerate the formation of a layer on the product.** [(See relevant web pages from Answers.com – copy attached; emphasis added.)]

Note that RTP involves the combination of "gas and heat" to form the desired layer.

We now turn to "molecular beam epitaxy." Molecular beam epitaxy" is described as follows:

Molecular beam epitaxy (MBE), is one of a number of methods of thin-film deposition. In solid-source MBE, ultra-pure **elements** such as gallium and arsenic are **heated** in separate quasi-knudsen effusion cells **until** they each slowly **begin to evaporate.** The **evaporated elements then condense on the wafer,** where they react with each other, forming, in this case, single-crystal gallium arsenide. The term 'beam' simply means that the evaporated atoms do not interact with each other or any other vacuum chamber gases until they reach the

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wafer, due to the large mean free path lengths of the beams. [(See relevant web pages from Answers.com – copy attached; emphasis added.)]

MBE also involves evaporated elements or precursors.

Thus, each of CVD, ion plating, RTP and MBE involve evaporated species, vapors and/or gases as indicated above. It is critical to remember this point in considering the disclosure of the Vaartstra reference (cited as prior art under 35 U.S.C. § 102(e)).

In particular, the Vaartstra reference states in relevant part (from col. 5, line 63 to col. 6, line 2 thereof) that:

Although a specific spin-coating process is described by reference to FIG. 2, the method of **the present invention [of Vaartstra]** is not limited to being used with **the specific spin-coating apparatus shown**. Furthermore, the method of the present invention [of Vaartstra] is **not limited to spin coating**. **Rather, other non-volatile deposition techniques can be used to deposit the metal carboxylate complexes described herein**. [(Emphasis added.)]

The highly relevant import of the foregoing quoted text from Vaartstra is that while the Vaartstra reference is “not limited to spin-coating” – it is – instead – limited to “other non-volatile deposition techniques.” The key here is that Vaartstra is limited to “other non-volatile deposition techniques” as expressly noted in Vaartstra at columns 5 and 6 thereof – as noted above. (Emphasis added.)

Even the non-final Office Action admits (at page 5, line 1 thereof) that:

Vaartstra (5,695,815) fails to teach coating by CVD.

Well, not only does Vaartstra fail to teach CVD, but Vaartstra also fails to teach any of the other deposition techniques (e.g., assisted-CVD, ion plating, RTP, and MBE) recited in Applicants’ rejected claims because these techniques involve volatile species, vaporization and formation of gasses (as indicated above) and Vaartstra specifically teaches that only “other non-volatile deposition techniques” may be used in place of spin-coating. (Emphasis added.)

Accordingly, Vaartstra fails to teach each and every limitation of all the claims rejected under 35 U.S.C. § 102(e) over Vaartstra. As such, Applicants respectfully request reconsideration and withdrawal of the rejection of claims 1, 3, 4, 16, 17-22, 26, 35 and 36 under 35 U.S.C. § 102(e) for the foregoing reasons.

Claims Rejection(s) under 35 U.S.C. § 103 over Vaartstra

Claims 2, 7, 14, 38, 39 and 42-45 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Vaartstra (U.S. Patent No. 5,695,815) for the reasons noted at page 4 of the Office Action. Applicants respectfully traverse the foregoing rejection of claims 2, 7, 14, 38, 39 and 42-45 rejected under 35 U.S.C. § 103(a) over Vaartstra.

Applicants prior comments and remarks regarding Vaartstra (with respect to the above-noted rejection of record under 35 U.S.C. § 102(e) over Vaartstra) are equally applicable to the instant rejection of claims 2, 7, 14, 38, 39 and 42-45 under 35 U.S.C. § 103(a) over Vaartstra. Accordingly, our prior remarks and comments are incorporated herein as if stated here without having to repeat the same.

In sum, Vaartstra teaches away from each of the various techniques recited in Applicants' rejected claims (those techniques being – CVD, assisted-CVD, ion plating, RTP, and MBE – each involving a volatile, vapor and/or gaseous species during deposition) because Vaartstra expressly limits its disclosure to spin-coating and “other non-volatile deposition techniques” as already noted above. (Emphasis added.) In other words, Applicants' claims recite deposition techniques that involve volatile species while Vaartstra is limited to non-volatile deposition techniques.

In view of the foregoing remarks and comments, Applicants respectfully request reconsideration and withdrawal of the rejection of claims 2, 7, 14, 38, 39 and 42-45 rejected under 35 U.S.C. § 103(a) as being unpatentable over Vaartstra.

Claims Rejection(s) under 35 U.S.C. § 103 over Vaartstra in combination with Nakabayashi et al.

Claims 13 and 15 are rejected under 35 U.S.C. 103(a) as being unpatentable over Vaartstra (U.S. Patent No. 5,695,815) in combination with Nakabayashi, et al. (U.S. Patent No. 6,271,077; hereinafter “Nakabayashi”) for the reasons noted at pages 4-5 of the Office Action.

Applicants' aforementioned comments and remarks regarding Vaartstra are equally applicable to the instant rejection of claims 13 and 15 under 35 U.S.C. § 103 (a) over Vaartstra in combination with Nakabayashi. Accordingly, Applicants incorporate herein their above noted comments and regarding Vaartstra as if restated here without having to repeat the same.

As noted, Vaartstra teaches away from utilizing deposition techniques recited in Applicants' rejected claims – namely – CVD, assisted-CVD, ion plating, RTP, and MBE for the reasons already noted herein. Nakabayashi cannot and does not negate the express teaching away of Vaartstra – that Vaartstra is limited to spin-coating and other non-volatile deposition techniques. In other words, the disclosure of Nakabayashi cannot and does not rectify the

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aforementioned deficiencies of Vaartstra. Accordingly, Applicants respectfully submit that there is no motivation to combine Nakabayashi with Vaartstra – especially in view of the teaching away of Vaartstra noted above. Therefore, in effect, combining Nakabayashi with Vaartstra (without the requisite motivation and in light of the express teaching away of Vaartstra) has been done with the impermissible use of hindsight reconstruction of Applicants' claimed invention based on the disclosure Applicants' own claims.

One is not at liberty to ignore the highly relevant and material teaching away of Vaartstra noted above. To do so would be to improperly deny Applicants their right to patent their invention.


In view of the foregoing, Applicants respectfully request reconsideration and withdrawal of the rejection of claims 13 and 15 under 35 U.S.C. § 103(a) over Vaartstra in combination with Nakabayashi.

CONCLUSION

The claims are now in proper form and condition for allowance. Favorable action is hereby requested. If any issues remain, incident to the formal allowance of the application, the Examiner is earnestly requested to contact the undersigned attorney at (919) 419-9350 to resolve same, so that the patent on this application can be issued at the earliest possible date.

Respectfully submitted,

Date: May 31, 2006


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Enclosures:

Web pages from Answers.com regarding CVD [3 pages]

Web pages from Answers.com regarding Ion Plating [3 pages]

Additional web page from www.mmc.or.jp/standard/term-e/list/i14.htm – regarding Ion Plating [1 page]

Web pages from Answers.com regarding RTP [1 page]

Web pages from Answers.com regarding MBE [3 pages]

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Chemical vapor deposition

Wikipedia

Chemical vapor deposition



DC plasma (violet) enhances the growth of carbon nanotubes in this laboratory-scale PECVD apparatus.

Chemical vapor deposition (CVD) is a chemical process often used in the semiconductor industry for the deposition of thin films of various materials. In a typical CVD process the substrate is exposed to one or more volatile precursors, which react and/or decompose on the substrate surface to produce the desired deposit. Frequently, volatile byproducts are also produced, which are removed by gas flow through the reaction chamber.

CVD is widely used in the semiconductor industry, as part of the semiconductor device fabrication process, to deposit various films including: polycrystalline, amorphous, and epitaxial silicon, carbon fiber, filaments, carbon nanotubes, SiO₂, silicon germanium, tungsten, silicon nitride, silicon oxynitride, titanium nitride, and various high-k dielectrics. The CVD process is also used to produce synthetic diamonds.

A number of forms of CVD are in wide use and are frequently referenced in the literature.

- Atmospheric pressure CVD (APCVD) - CVD processes at atmospheric pressure.
- Atomic layer CVD (ALCVD) (also referred to as Atomic Layer Epitaxy and Atomic layer deposition (ALD)) - A CVD process in which two complementary precursors (eg. Al(CH₃)₃ and H₂O) are alternatively introduced into the reaction chamber. Typically, one of the precursors will adsorb onto the substrate surface, but cannot completely decompose without the second precursor. The precursor adsorbs until it saturates the surface and further growth cannot occur until the

<http://www.answers.com/main/ntquery?tname=chemical%2Dvapor%2Ddeposition&print=...> 5/30/2006

second precursor is introduced. Thus the film thickness is controlled by the number of precursor cycles rather than the deposition time as is the case for conventional CVD processes. In theory ALCVD allows for extremely precise control of film thickness and uniformity.

- **Aerosol Assisted CVD (AACVD)** - A CVD process in which the precursors are transported to the substrate by means of a liquid/gas aerosol, which can be generated ultrasonically. This technique is suitable for use with involatile precursors.
- **Hot Wire CVD (HWCVD)** - Also known as Catalytic CVD (Cat-CVD) or Hot Filament CVD (HFCVD)
- **Low-pressure CVD (LPCVD)** - CVD processes at subatmospheric pressures. Reduced pressures tend to reduce unwanted gas phase reactions and improve film uniformity across the wafer. Most modern CVD processes are either LPCVD or UHVCVD.
- **Metal-organic CVD (MOCVD)** - CVD processes based on metal-organic precursors, such as Tantalum Ethoxide, $\text{Ta}(\text{OC}_2\text{H}_5)_5$, to create Ta_2O_5 , Tetra Dimethyl amino Titanium (or TDMAT) to create TiN. MOCVD is also called as MOMBÉ when it is under ultra-high vacuum.
- **Microwave plasma-assisted CVD (MPCVD)**
- **Plasma-Enhanced CVD (PECVD)** - CVD processes that utilize a plasma to enhance chemical reaction rates of the precursors. PECVD processing allows deposition at lower temperatures, which is often critical in the manufacture of semiconductors. See also Plasma processing.
- **Rapid thermal CVD (RTCVD)** - CVD processes that use heating lamps or other methods to rapidly heat the wafer substrate. Heating only the substrate rather than the gas or chamber walls helps reduce unwanted gas phase reactions that can lead to particle formation.
- **Remote plasma-enhanced CVD (RPECVD)** - Similar to PECVD except that the wafer substrate is not directly in the plasma discharge region. Removing the wafer from the plasma region allows processing temperatures down to room temperature.
- **Ultra-high vacuum CVD (UHVCVD)** - CVD processes at very low pressures, typically in the range of a few to a hundred millitorrs (1 to 10 pascals).
- Polysilicon deposition
- TEOS deposition

Silicon or silicon germanium epitaxy

Common use in industry is the growth of additional layers of doped silicon on the polished sides of prime silicon wafers, before they are processed into semiconductor devices. This is typical of the power devices, such as those used in pacemakers, vending machine controllers, automobile computers, etc.

Commonly, this is accomplished by either single or batch wafer processing using CVD in an epitaxial reactor, which heats the wafers, etches the exposed face with hydrogen

chloride gas, and then grows the epitaxial layers by flowing a gas mixture that contains silicon and a dopant over the wafer which is so hot that it glows. The gaseous molecules deposit on the face, if done properly, and extend the crystalline structure.

Manufacturing issues include control of the amount and uniformity of the deposition's resistivity and thickness, the cleanliness and purity of the surface and the chamber atmosphere, the prevention of the typically much more highly doped substrate wafer's diffusion of dopant to the new layers, imperfections of the growth process, and protecting the surfaces during the manufacture and handling.

See also

- [Plasma](#)
- [Physical vapor deposition](#)

External links

- <http://www.semiconfareast.com/epitaxy.htm>

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ion plating

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ion plating

Ion plating is a physical vapor deposition technique to form metal coatings on metals and alloys.

The specimen to be coated is placed in an inert gas (often argon), together with some coating material. Next, a certain heating temperature and a low-voltage arc is applied to evaporate the metallic component of the coating material. The ionized particles are accelerated to a high energy, and the coating is formed due to the bombardment of these accelerated particles, reaching the specimen to be coated.

The biggest difference between ion plating and sputtering is the way of creating the ionized particles. Instead of evaporation by a low-voltage arc, in sputtering the metal ions are removed from a metal plate by bombardment with argon ions.

See also

- [List of coating techniques](#)

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Ion plating

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[DEFINITION]

A vapor deposition in which the vaporized particles are ionized or energized in plasma and deposited on the substrate by applying kinetic energy through an electrical field.

[DESCRIPTION]

This is a composite technology combining vacuum deposition and plasma technology. Whereas in the conventional vacuum deposition process, most of the particles that reach the substrate are neutral, in this method, the particles are ions, excited particles, and radicals with internal energy and kinetic energy. Therefore, compared with vacuum deposition, the structure and properties of the plated film are much more elaborate. Because the deposition rate is also high and the properties of the film are good, this method is used extensively instead of electroplating, especially in the production of a layer on nonconductive materials.

[References]

(4)(9)

[Related Terms]

Vapor deposition □

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Rapid thermal processing

Wikipedia



Rapid thermal processing

Rapid thermal processing (or RTP) is conducted on the product (e.g. solar cells) in a high temperature oven. The gas and heat combine to accelerate the formation of a layer on the product. This process is also being used to reduce current leakage in transistors by researchers at the University of Kentucky. [1]

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Molecular beam epitaxy

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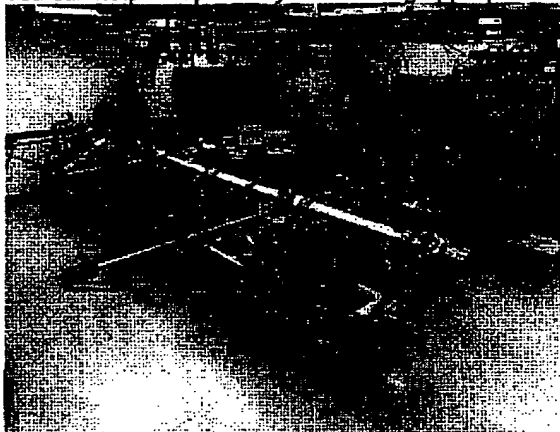
A technique that "grows" atomic-sized layers on a chip rather than creating layers by diffusion.

Wikipedia



Molecular beam epitaxy

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Molecular Beam Epitaxy System in the William R. Wiley Environmental Molecular Sciences Laboratory is used to grow and characterize thin crystalline films of oxides and ceramics to understand in detail the chemistry that occurs on oxides and ceramic surfaces.

Molecular beam epitaxy (MBE), is one of a number of methods of thin-film deposition. In solid-source MBE, ultra-pure elements such as gallium and arsenic are heated in separate quasi-knudsen effusion cells until they each slowly begin to evaporate. The evaporated elements then condense on the wafer, where they react with each other, forming, in this case, single-crystal gallium arsenide. The term "beam" simply means that evaporated atoms do not interact with each other or any other vacuum chamber gases until they reach the wafer, due to the large mean free path lengths of the beams.

A computer controls shutters in front of each furnace, allowing precise control of the thickness of each layer, down to a single layer of atoms. Intricate structures of layers of different materials may be fabricated this way. Such control has allowed the development of structures where the electrons can be confined in space, giving quantum wells or even quantum dots. Such layers are now a critical part of many modern semiconductor devices, including semiconductor lasers and light emitting diodes.

<http://www.answers.com/main/ntquery?name=molecular%2Dbeam%2Depitaxy&print=true> 5/30/2006

During operation, RHEED (Reflection High Energy Electron Diffraction) is often used for monitoring the growth of the crystal layers.

The ultra-high vacuum environment within the growth chamber is maintained by a system of cryopumps, and cryopanel, chilled using liquid nitrogen to a temperature of 77 kelvins (-196 degrees Celsius). The wafers on which the crystals are grown are mounted on a rotating platter which can be heated to several hundred degrees Celsius during operation.

Molecular beam epitaxy is also used for the deposition of some types of organic semiconductors. In this case, molecules, rather than atoms, are evaporated and deposited onto the wafer. Other variations include gas-source MBE, which resembles chemical vapor deposition but in vacuum.

Molecular beam epitaxy was invented in the late 1960s at Bell Telephone Laboratories by J. R. Arthur and A. Y. Cho.

See also

- Alfred Y. Cho
- Arthur Gossard
- Herbert Kroemer
- Solar cell
- Wetting layer

External links

- Vapor pressure curves of the elements
- University of Texas MBE group
- Physics of Thin Films: Molecular Beam Epitaxy (class notes)

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